View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Bowling Green State University: ScholarWorks@BGSU

Bowling Green State University

ScholarWorks@BGSU

Honors Projects

Honors College

Spring 2014

Prelude - An Augmented Reality iOS Application for Music Education

Kristen Brown
brownke@bgsu.edu

Follow this and additional works at: https://scholarworks.bgsu.edu/honorsprojects

 Part of the Curriculum and Instruction Commons, Educational Methods Commons, and the Software Engineering Commons

Repository Citation

Brown, Kristen, "Prelude - An Augmented Reality iOS Application for Music Education" (2014). *Honors Projects*. 112.
https://scholarworks.bgsu.edu/honorsprojects/112

This work is brought to you for free and open access by the Honors College at ScholarWorks@BGSU. It has been accepted for inclusion in Honors Projects by an authorized administrator of ScholarWorks@BGSU.

Prelude – An Augmented Reality iOS Application for Music Education

Honors Project for Kristen Brown
Bowling Green State University
Bowling Green, Ohio, USA
brownke@bgsu.edu

Advisors:
Dr. Joseph T. Chao
Department of Computer Science
Bowling Green State University
jchao@bgsu.edu

Dr. Kenneth Thompson
College of Musical Arts
Bowling Green State University
thomken@bgsu.edu

Abstract

Augmented reality (AR) is a technology which serves to enhance the real world environment through the addition of relevant digital content, and has many potential applications within a variety of different fields, including, but not limited to, fields such as marketing, entertainment, medicine, and education. The purpose of this project is to develop an iOS augmented reality application for music educators that will serve as a tool in teaching students to recognize specific music notes and symbols.

Keywords: augmented reality, education, music, iOS development, optical music recognition, Qualcomm Vuforia SDK

Introduction

Although applications of augmented reality (AR) have existed since as early as the 1960s or 1970s, the field did not come into its own since close to the 1990s, when certain hardware advances made it possible to implement virtual worlds that merged with the real world to create entirely new sensory experiences. However, these early AR prototypes were awkwardly implemented at best and often required the user to wear special head-mounted displays or to lug around heavy computer and electrical equipment. Since the advent of the smartphone and other smart devices such as tablets, AR research has grown immensely, giving birth to new, creative applications for augmented reality which enhance our sensory experiences and provide us new ways in which to experience information.

Augmented reality differs from virtual reality in the way that it uses digital content to enhance the real world environment rather than replacing the real world entirely and forcing the user to enter

an entirely virtual world. Instead, AR attempts to improve upon the real world by assessing the real world environment and then reacting to what it sees through the presentation of relevant digital content to the user. This digital content can be in the form of text, video, audio, 3D objects, or images, and new digital media types are being incorporated into AR applications over time in order to create new experiences for users.

A prominent and noteworthy example of recent augmented reality technology is Google Glass. This wearable technology was developed by Google and provides an optical head-mounted display (OHMD) as the primary lense for seeing into the world. However, in the case of Google Glass, this world is augmented with visual, informational content such as navigational directions or other data that may relate to the user's current surroundings.

Another example of augmented reality is IKEA's smartphone application which allows a customer to scan a particular houseware in the company's catalog using his or her smartphone camera and access additional content about that item. The customer can even use a smartphone to see what the item would look like in his or her current space.

Augmented reality technology opens up many doors for new applications that are both useful and inspiring. Prelude is one of these such applications. Although learning the fundamental notes and symbols in music is a necessary first step to learning how to read music, it is not a particularly engaging topic in and of itself. Knowing this fact, music teachers have for decades used games as a way to generate student interest in learning these fundamental concepts. Prelude seeks to improve upon these games by adding augmented reality to the mix. The addition of augmented reality is expected to generate greater student interest in the topic and a faciliate a deeper engagement with the material because it allows the students to operate in a mode that is inherently compelling to them: a technological mode. Augmented reality in particular is a great tool to utilize in an educational application because of its awe-inspiring nature and appeal with students and adults alike.

Prelude

Prelude is made up of two components: an iOS quiz application for students to learn how to recognize specific music notes and symbols and an adminstrative website for teachers to personalize music quizzes for their students and to view their students' quiz results. Therefore, it is a two-way, collaborative approach, where teachers develop content for their students and the students use this content to deepen their understanding of the course material.

The iOS game application has two game modes, a "quiz mode" and a "free play mode." Selecting the "quiz mode" option allows the student to take a graded or ungraded quiz created by the teacher. By selecting the "free play" option, the student has free reign to scan any music symbols or notes known by the system (and there are many), and the application will tell them which note or symbol they scanned with their device camera. The application does not require that they take a picture of the scene because it recognizes images in real time from the camera's video feed. "Quiz mode" requires that the student is logged in to the application, but "free play" does not have this requirement, and the student can play even when there have been no quizzes created for him or her, or if the available quizzes have already been completed.

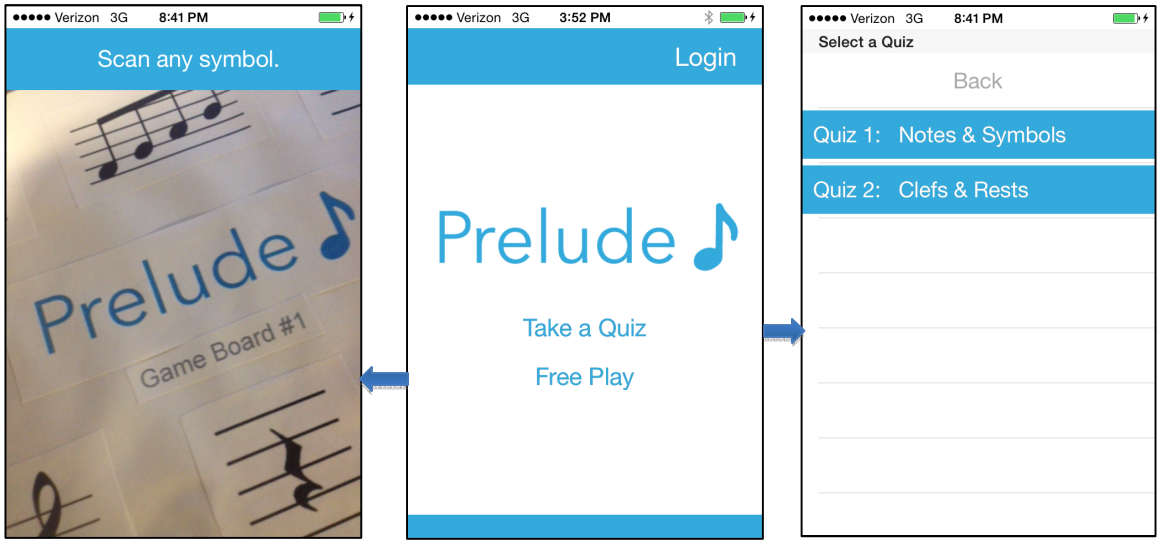

Figure 1. Two main game modes of Prelude iOS application.

In both scenarios, it is expected that the classroom teacher will provide appropriate printouts of the desired notes and symbols for the lesson. When playing in "free play mode," the student can scan any of the symbols provided by the teacher, in any order. By contrast, when playing in "quiz mode," after the student selects a specific quiz, the application will begin asking him or her to find and scan specific notes or symbols, one at a time and in a specific order. As the student progresses, the application will alert him or her whether each answer was correct, and if the symbol has a note value, the note will play through the device's speakers upon a correct identification, reinforcing the identification in the student's mind. Once all of the questions have been completed, the application will then alert the student of his or her grade on the quiz, such as 9/10. Then the student is able to return to the main screen to take another quiz or to play in "free play mode."

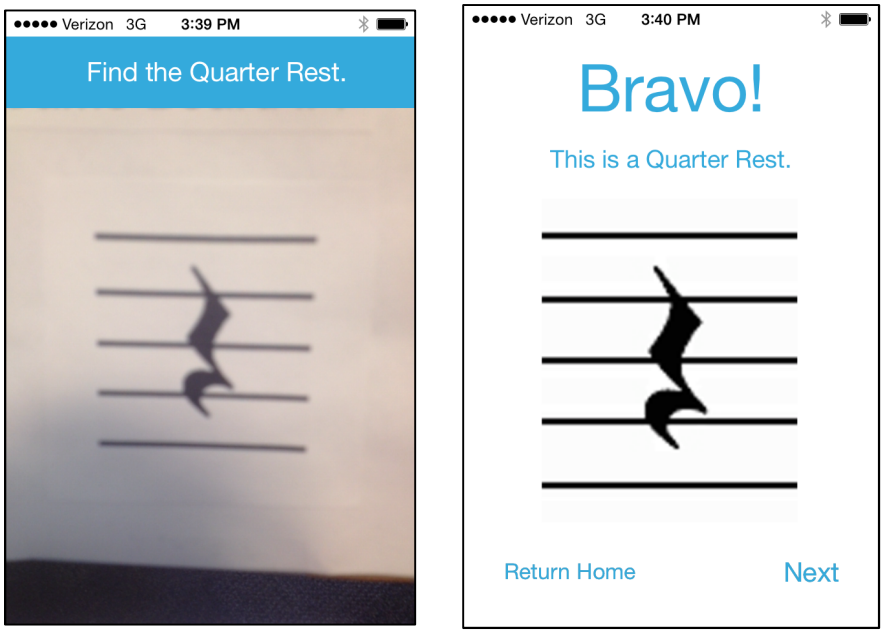

Figure 2. Scanning and recognizing a music symbol.

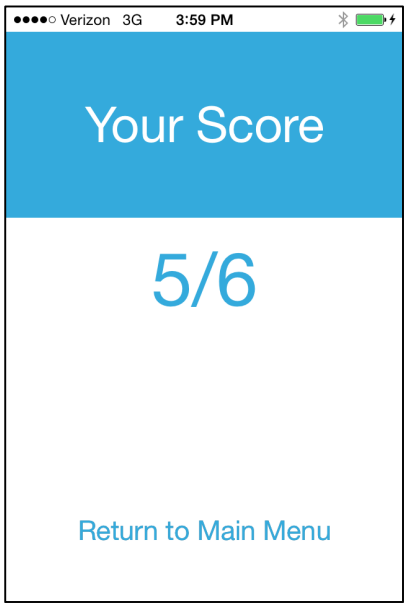

Figure 3. Student quiz results screen.

The second component of the project is its administrative website for teacher quiz creation and customization. After the teacher logs into the website, he or she has the ability to create a new quiz, edit or delete an existing quiz, view his or her students' results, and manage a roster of student accounts.

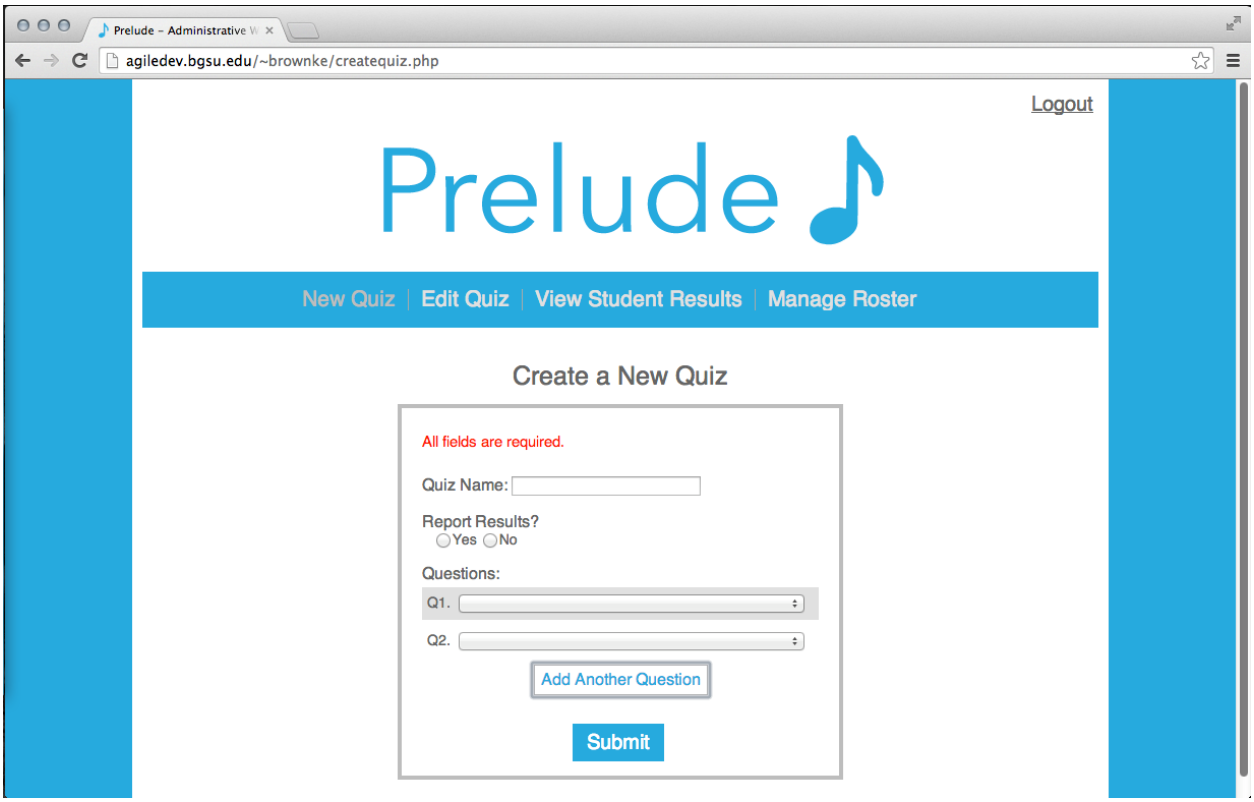

Figure 4. Prelude Administrative Website.

When creating a quiz, the teacher selects from a set of defined music symbols and notes whose corresponding images have been optimized for recognition by the Prelude iOS application. Also when creating a quiz, teachers have the option whether or not to set the quiz up to report the students' results. If the teacher would like to create an ungraded practice quiz, he or she has the ability to do so.

Implementation

Technology

Apple's iOS SDK (Software Development Kit), Xcode IDE (Integrated Development Environment), and the Objective-C programming language were used to develop the Prelude iOS application for student use. When discussing how to implement the image recognition and augmented reality components of the application, three main options were considered: the Metaio SDK, Qualcomm's Vuforia SDK, or a self-written algorithm. The Metaio SDK was tested first. Unfortunately, its image recognition performed very poorly with the black-and-white music symbols, as there was not enough detail in the images for the Metaio SDK to properly recognize. Qualcomm's Vuforia SDK was tested next, and performed far better than Metaio's SDK, well enough to be used in practice for this particular application. One trick to improving the recognition capabilities of the Vuforia SDK was to add twenty-pixel-wide white margin around the image so that the ends of the staff lines could be detected and the notes properly identified. The final option, a self-written algorithm, would likely have worked well, but as the Vuforia SDK already provided accurate recognition with good performance, it was not necessary to spend the time implementing such an algorithm, and the time was better spent on the application's other features.

To implement the Prelude administrative website, a server and a MySQL database were used. HTML and CSS were used to create the shell of the website, Javascript to implement data validation on the forms, and PHP to interact with the server and database.

Prelude Data Flow

This project uses a client-server model, where the iOS application acts as the client and the server and server-side software provide quiz and user data to the iOS application. Whenever the teacher creates a new quiz, updates a quiz, deletes a quiz, or creates a new student account, the changes are reflected in the database. Then, as a student uses the iOS application, relevant data stored in the database is downloaded to the application upon application demand. This fetching of data relies on the iOS framework AFNetworking, a popular open source technology.

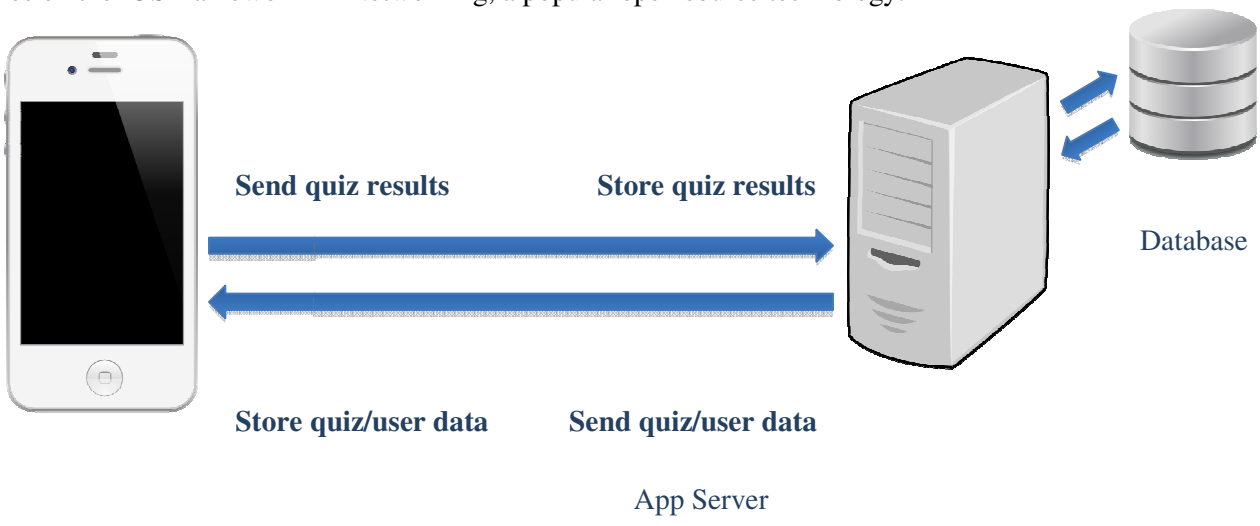

Figure 5. Prelude data flow between client and server.

Prelude iOS App

Future Work

There are several features that could be added to Prelude to broaden its capabilities. The first would be to upgrade the administrative website to allow for even greater customization by the classroom teacher, such as the ability to add his or her own music-related images for students to recognize, or the ability to view quiz results sorted by a specific class or student, in addition to viewing them by quiz name. Another feature that could be implemented is the ability for students to view their personal quiz results on demand, and not just at the end of a particular quiz. In addition, the application could be upgraded to provide more detailed quiz results, such as quiz average over time or a list of the particular questions the student answered correctly or incorrectly.

The application could also be expanded to recognize musical phrases or scales. This feature would not be difficult to implement because the application in its design is very scalable. In addition, more complex sound functionality could be added to the application, such as the ability to play back musical phrases in addition to single notes, or to provide educational information in the form of audio when the student scans a symbol that has no corresponding note value.

Conclusion

Augmented reality, though still considered a fledgling field by many technologists, has great potential to transform the way we interact with the world around us. It, rather than virtual reality, has the ability to ground us in the physical world while still providing us an experience greater in impact than what the physical world provides alone. As more powerful and cheaper hardware capable of robust image recognition and advanced object rendering continue to be developed, augmented reality will find its home in even more other areas of our lives.

Within the fields of education, AR can be used to increase student engagement with course material and provide an alternative method of instruction for teachers to apply in their classrooms. Prelude is an example of an application that seeks to meet these objectives and fill a gap for more technologically-inspired educational methods designed for twenty-first century students.

References

Arshad, Quratul-Ain, Wazir Zada Khan, and Zohair Ihsan. "Overview of Algorithms and Techniques for Optical Music Recognition." *4th CIIT Workshop on Research in Computing (4th CWRC Fall 2006)* (2006): n. pag. Web.

Azuma, Ronald T. "A survey of augmented reality." *Presence* 6.4 (1997): 355-385.

Fernández, Víctor, Juan M. Orduña, and Pedro Morillo. "How mobile phones perform in collaborative augmented reality (CAR) applications." *The Journal of Supercomputing* (2013): 1-13.

Herling, Jan, and Wolfgang Broll. "Markerless Tracking for Augmented Reality." *Handbook of Augmented Reality*. Springer New York, 2011. 255-272.

IKEA | Catalog (2014). *2014 IKEA Catalog*. IKEA, n.d. Web.

"iOS Developer Library." *iOS Developer Library*. Apple Inc., n.d. Web.

Johansen, Linn Saxrud. "Optical music recognition." (2009).

Kang, Tim, and Michael Perry. "Optical Music Recognition Without Staffline Removal."

Kipper, Greg, and Joseph Rampolla. *Augmented Reality: An Emerging Technologies Guide to AR*. Elsevier, 2012.

Low, Grady, and Yung-Ho Chang. "Optical Music Recognition Application."*Group* 3 (2012): 30.

Luangnapa, Nawapon, et al. "Optical Music Recognition on Android Platform."*Advances in Information Technology*. Springer Berlin Heidelberg, 2012. 106-115.

MacMillan, Karl, Michael Droettboom, and Ichiro Fujinaga. "Gamera: Optical music recognition in a new shell." *Proceedings of the international computer music conference*. 2002.

Medicherla, Padmavathi S., George Chang, and Patricia Morreale. "Visualization for increased understand ing and learning using augmented reality." *Proceedings of the international conference on Multi media information retrieval*. ACM, 2010.

Radu, Iulian, and Blair MacIntyre. "Using children's developmental psychology to guide augmented-reality design and usability." *Mixed and Augmented Reality (ISMAR), 2012 IEEE International Symposi um on*. IEEE, 2012.

Rebelo, Ana, et al. "Optical music recognition: state-of-the-art and open issues." *International Journal of Multimedia Information Retrieval* 1.3 (2012): 173-190.

Soontornwutikul, Thanachai, et al. "Optical Music Recognition on Windows Phone 7." *The 9th Interna tional Conference on Computing and InformationTechnology (IC2IT2013)*. Springer Berlin Hei delberg, 2013.